Performance Measurement and Analysis of AODV and DYMO Routing Protocols for MANET under Free Space and Two Ray Propagation Models

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ABSTRACT
MANET is a collection of dynamic mobile wireless nodes. These nodes are communicating with each other through wireless link. In MANET there is no need of pre-existing fixed network infrastructure. Since, in MANET the network topology changes dynamically due to the mobility of nodes thus, routing becomes a challenging issue. For optimizing the route between source and destination, a variety of routing protocols for varying network conditions have been analyzed and this is the active area of research for authors. IETF MANET Working Group have been standardized the most popular reactive routing protocol AODV and DYMO which are used in MANETs. In our paper, we present performance comparison results of two reactive routing protocols namely AODV and DYMO under Free Space and Two Ray propagation models by varying packet rate, using Discrete-event simulator QualNet version 5.2. Simulations are run to analyze the different network parameters such as throughput, average end-to-end delay, average jitter, packet delivery ratio and total bytes received.

Keywords
MANETs, AODV, DYMO, Free Space Propagation model, Two Ray Propagation model, Constant Shadowing model, QualNet version 5.2.

1. INTRODUCTION
In MANETs there are no needs of pre-existing fixed network infrastructure. MANETs is a collection of dynamic mobile wireless nodes in which mobile nodes are communicating with each other using wireless links. Applications area of MANET are very large viz. military operations, disaster managements, rescue operations, meetings and conferences, educational purposes and many more. Since, in MANET the network topology changes frequently, due to the mobility of nodes. Therefore, routing becomes a challenging issue. For optimizing the route between source and destination, a variety of routing protocols for varying network conditions have been analyzed and this is the active area of research for authors. To handle this MANET needs different types of routing protocols, some of them are: AODV [1, 2], DYMO [3], OLSR [5], TORA [4], DSR [7], ZRP [6] etc. The two most popular reactive routing protocols for MANETs namely Ad Hoc On-demand Distance Vector (AODV) and Dynamic MANET On-demand (DYMO), where the routes is only discovered when needed or on demand, which justifies its reactive property. The IETF MANET Working Group has been standardized AODV [2] and DYMO [3].

Propagation models focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location [12]. Propagation models like Free Space and Two Ray ground have been used for communication purpose.

The aim of this paper to evaluates the performance of AODV and DYMO by varying the packet rate under Free Space and Two Ray propagation models. The rest of the paper is organized as follows: Section–2 introduces Routing Protocols; Section-3 gives the simulation environment. Section-4 presents simulation results and discussion and performance comparison graphs. Finally, conclusion is presented in Section-5.

2. ROUTING PROTOCOLS

2.1 Ad-hoc On Demand distance Vector routing protocol (AODV)
AODV [1, 2] is a reactive routing protocol. The Ad hoc On-Demand Distance Vector (AODV) algorithm enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to establish and maintain an ad hoc network [2]. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. The operation of AODV is loop-free. When a route to a new destination is needed, the node broadcasts a RREQ to find a route to the destination. A route can be determined when the RREQ reaches either the destination itself, or an intermediate node with a 'fresh enough' route to the destination [2]. A 'fresh enough' route is a valid route entry for the destination whose associated sequence number is at least as great as that contained in the RREQ. The route is made available by unicasting a RREP back to the origination of the RREQ. Each node receiving the request caches a route back to the originator of the request, so that the

RREP can be unicast from the destination along a path to that originator, or likewise from any intermediate node that is able to satisfy the request [2].

In AODV route maintenance is done by HELLO messages and route error (RERR) messages. Nodes monitor the link status of next hops in active routes. When a link break in an active route is detected, a RERR message is used to notify other nodes that the loss of that link has occurred. After receiving RERR the source node initiates the new procedure for route discovery [2].

Although AODV is the most famous protocol of MANET among all routing protocols but AODV has a heavy routing overhead and complexity problem as regards implementation [10].

2.2 Dynamic MANET On-demand routing protocol (DYMO)

DYMO is also a reactive routing protocol. In which, the routes is only discovered when needed or on demand. Dynamic MANET On-demand routing protocol (DYMO) [3] enables on-demand, multi-hop unicast routing among routers in mobile ad-hoc networks. The basic operations of the protocol include route discovery and route maintenance. When a router wants to transmit a packet towards a destination node for which it does not have a route, route discovery is performed. Route maintenance is used to avoid dropping packets, when a route from the source node to a destination node breaks [3].

In the route discovery, a router broadcast a Route Request message (RREQ) throughout the network to find a route to required destination node. After receiving the RREQ message each intermediate node records a route to the originator [3]. When the destination's DYMO router receives the RREQ, it sends a RREP to the originator. When the originator receives the RREP, the route is established [10]. Route maintenance consists of two operations. In order to preserve routes in use, routers extend route lifetimes upon successfully forwarding a packet [3]. In order to react to changes in the network topology, routers monitor traffic being forwarded. When a data packet is received for forwarding and a route for the destination is not known or the route is broken, then the router of the source of the packet is notified [3]. A Route Error (RERR) is transmitted to indicate the route to one or more affected destination addresses is Broken or missing. When the source's router receives the RERR, it marks the route as broken. Before the DYMO router can forward a packet to the same destination node, it has to perform route discovery again for that destination node [3]. In DYMO path accumulation function can reduced the routing overhead, although the packet size of routing packet is increased [10].

3. SIMULATION ENVIRONMENT

We had done simulations on QualNet 5.2 [8] and defined the parameters for the performance evaluation of AODV and DYMO routing protocols under different propagation model and varying packet rate i.e. packets per second. Many authors [10, 11, 12, 13] have been worked with AODV, DYMO and other routing protocols with different network conditions for evaluating performance. We have simulated the experiment under two propagation models namely Free Space and Two Ray by varying packet rate. We have taken terrain area 1000x1000 m^2 and placing 75 nodes randomly. We have applied 9 CBR application, keeping mobility 0-10 mps, pause time 10 sec and taking simulation time 150 seconds. We have varied packet rate to 1,2,3,4,5,6,7 and 8.

Free-Space propagation model [9, 13] is used to predict the signal strength when the transmitter and the receiver have a clear, unobstructed line-of-sight path between them. The free space power received by the receiver antenna at a given distance from the transmitter is given by the Friis free space equation [9, 13]. The two-ray ground reflection model [9, 13] is based on geometric optics, and considers both the direct path and a ground reflected path between transmitter and receiver.

The simulation parameters are shown in table 1 and the simulation results are shown in figures from 1 to 5.

With the help of simulation results we have analyzed Packet delivery ratio, Throughput, End-to-End delay, Average Jitter and Total Bytes Received for the given protocol.

3.1. Throughput: Throughput is defined as the total amount of data received by destination node from the source node divided by the total time it takes from the destination to get the last packet. Throughput is measured in bits per second (bit/s or bps).

3.2 Average Jitter: Jitter is the time variation between subsequent packet arrivals; it is caused by network congestion, timing drift, or route changes. For an efficient protocol, it must be as low as possible.

3.3 Average End-to-End delay*:* Average end-to-end delay is the time interval when a data packet generated from source node is completely received to the destination node.

3.4 Packet delivery ratio: Packet delivery ratio is the ratio of total packets sent by the source node to the successfully received packets by the destination node.

3.5 Total Bytes Received: The amount of data received by the destination node in terms of bytes.

TABLE 1. SIMULATION PARAMETERS

Simulation Parameters	Values
Area	1000x1000
No. of nodes	75
Simulation Time	150
Routing Protocols	AODV, DYMO
Number of Channel	1
Channel frequency	2.4 GHz

Shadowing Model	Constant
Pathloss Model	Two-Ray, Free-Space
Mobility Model	Random way point
Mobility Speed	0-10 mps
Pause Time	10 sec
Packets per second	1,2,3,4,5,6,7,8
Item size	512 bytes

4. SIMULATION RESULTS AND DISCUSSION

Fig. 1 shows the Throughput of AODV and DYMO under Free Space and Two Ray propagation model, when increasing the packet rate. For Free Space propagation model, the throughput of AODV and DYMO is almost same for packet rate >4 pps but above this AODV performs better. For Two Ray propagation model, AODV perform better than DYMO. Overall AODV perform better than DYMO in both the propagation model.

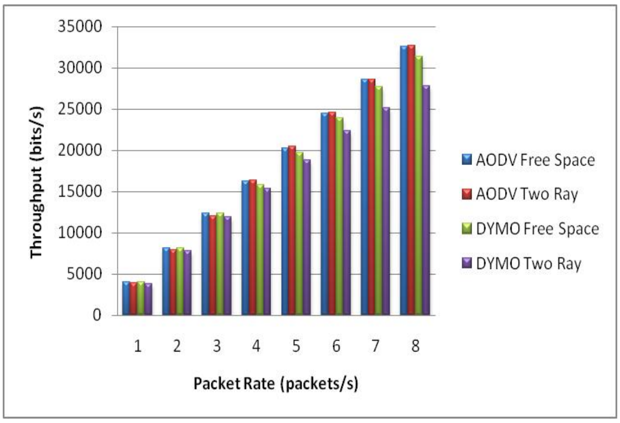

Fig. 1: Throughput Vs Packet rate

Fig. 2 shows the Average Jitter of AODV and DYMO under Free Space and Two Ray propagation model, when increasing the packet rate. For the Free Space model, AODV has lower jitter than DYMO. For Two Ray model, for packet rate 2 and 3 DYMO has lower jitter but for all other DYMO performs worst. Overall DYMO performs worst in both the conditions.

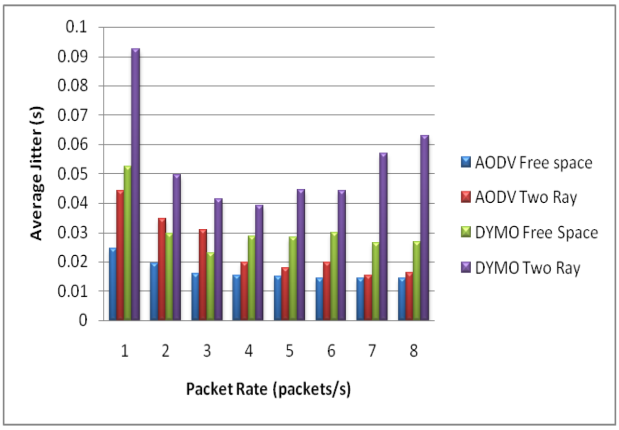

Fig. 2: Average jitter Vs Packet rate

Fig. 3 shows the average end-to-end delay of AODV and DYMO under Free Space and Two Ray propagation model, when increasing the packet rate. For both the propagation model AODV has lower average delay and have almost constant value than DYMO. Average Delay of DYMO under Two Ray model increases with increasing packet rate and performs worst.

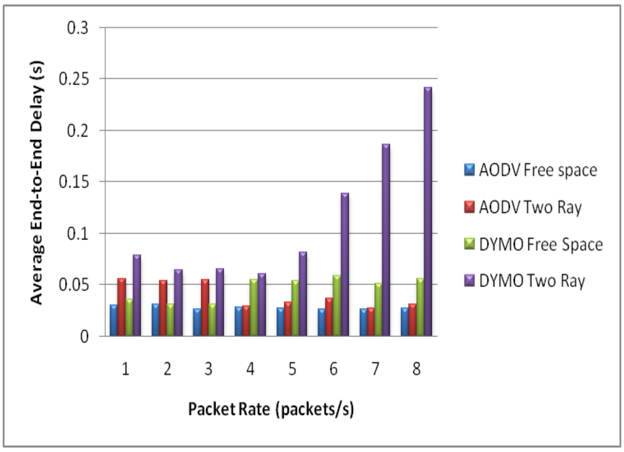

Fig. 3: Average End-to-End Delay Vs Packet rate

Fig. 4 shows the packet delivery ratio of AODV and DYMO under Free Space and Two Ray propagation model, when increasing the packet rate. For both the propagation models AODV have higher deliver ratio than DYMO. AODV have almost constant delivery ratio for both propagation model while the packet delivery ratio of DYMO for Two Ray is continuously decreasing with increasing packet rate.

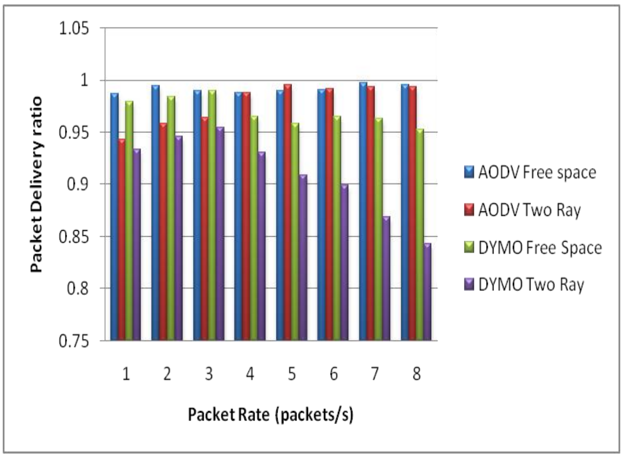

Fig. 4: Packet Delivery Ratio Vs Packet rate

Fig. 5 shows the total bytes received of AODV and DYMO under Free Space and Two Ray propagation model, when increasing the packet rate. For both the propagation models, AODV received more bytes than DYMO and continuously increasing with packet rate. Overall in both the cases AODV performs better. While DYMO, under Two Ray model performs worst among all.

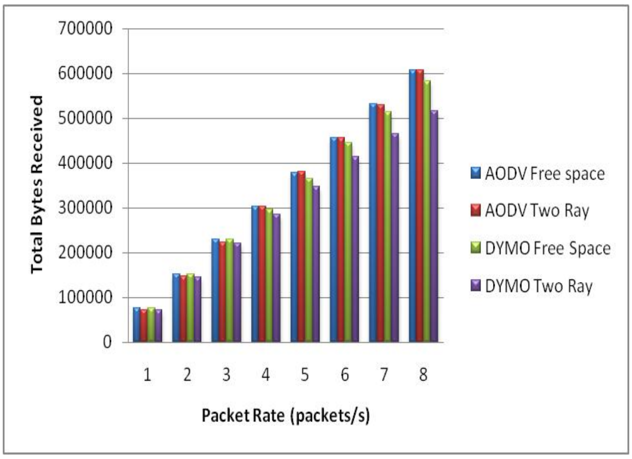

Fig. 5: Total Bytes Received Vs Packet rate

5. CONCLUSION

With simulation result we compared two reactive routing protocols for MANET namely AODV and DYMO under Free Space and Two Ray propagation model, when increasing the packet rate. We measure the average jitter, average end-to-end delay, packet delivery ratio, throughput and total bytes received as performance metrics. Our simulation result shows that AODV for Free Space and Two ray propagation models performs better than DYMO for Free Space and Two ray propagation models. Among all DYMO for Two Ray propagation model shows worst performance when packet rate is increases. We can also observe AODV performs very well under Free Space propagation model rather than Two Ray; it is because in Two Ray the probability of packet loss is more due to multipath propagation.

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